ISSN: 2287-688X

Annals of
Plant Sciences

Volume 14, Issue 11 (2025) pp. 7034-7045

Research Article

Screening of Common Bean (*Phaseolus vulgaris* L.) Accessions for Their Resistance to Fungal Diseases

Meka S. S.[1,2], Afsah M. N. M.[1], Babagnack B. F.[1], Djeugap F. J.[1]

[1]*Phytopathology and Agricultural Zoology Research Unit, Dschang School of Agriculture and Environnemental Sciences, University of Dschang, Cameroon*

[2] *Institute of Agricultural Research for Development (IRAD), Yaounde, Cameroon*

Abstract

Common bean (*Phaseolus vulgaris* L.) is the most cultivated and consumed legume in the western highlands of Cameroon. Despite its socio-economic importance, its cultivation encounters several problems among which pests and diseases contribute significantly to yield reduction. In order to improve the productivity of common bean, a varietal screening trial was set up in the locality of Dschang to study its resistance to fungal diseases in 2020 and 2021. Thus, 32 bean accessions, including 17 climbing and 15 dwarf were cultivated in a completely randomized block design. Data collection involved agronomic characteristics such as growth variables and yields, as well as diseases identification. The International Centre for Tropical Agriculture (CIAT) scale was used to assess disease incidence and severity. Data analysis was carried out using R software as statistical tool. Results showed that the climbing accession Mac 55 gave the highest yield in two years of the trial (4.57 $t.ha^{-1}$ and 3.66 $t.ha^{-1}$ respectively). Three major fungal diseases were identified in the field: angular leaf spot (ALS), floury leaf spot (FLS) and rust. Mancha 3 was among the most ALS susceptible accessions with an incidence of 100%, while RWR 3194 and Banguem were among the most resistant accessions to ALS (33.33%), 70 days after sowing (DAS). Concerning FLS, Banguem and Guzan local were among those with the highest incidence (100 %) while Losakia and Nuv 6 were among those with the lowest incidence (6.67 %) in 2020. Losakia and Kabo-6F9-8-27 were the accessions with the highest incidence (80 %) related to rust in both years. At the end of the study Mac 55 and RWR 3194 could be recommended as high yielding and also with a good resistance to the main fungal diseases encountered

Keywords: *Agronomic characteristics, Common beans, Fungal disease, Resistant accessions.*

Introduction

Common bean (*Phaseolus vulgaris* L.) is an important component of the production systems and a dietary legume for more than 300 million people, especially in developing countries. The total production exceeds 23 million tons out of which seven million are produced in Latin America and Africa (Ngueguim, *et al.,* 2011). It has an average per capita consumption of about 31.4 kg per year in the major production areas in northern Africa. Over 3.5 million hectares are occupied by common beans in sub- Saharan Africa, accounting for 25% of global production (Gereziher, *et al.,* 2017). This legume has a short growth cycle of approximately 65-110 days, it is mostly cultivated as subsistent farming, mainly by women (Siri, *et al.,* 2020).

In Cameroon, common beans are the 3rd most widely consumed legume after groundnut and cowpea (Nchanji, *et al.,* 2023). The biggest production and marketing of common beans is achieved in the western highlands with more than 90% of national production. It is mostly cultivated by small scale farmers for food and as a source of income (Siri, *et al.,* 2017). Farmers in the western highlands of Cameroon suffer low yields due

***Corresponding Author:**
Meka S. S.;

DOI: 10.5281/zenodo.17750445

to attacks by fungal diseases such as rust and angular leaf spots (ALS) among other plants diseases (Sanyang, *et al.,* 2019). In order to improve productivity of common beans, a screening on 32 bean accessions was carried out. The objective of the trial was to evaluate some agronomic characteristics of bean accessions and their resistance/susceptibility to fungal diseases.

Material And Methods

Experimental design, sowing and crop maintenance

Thirty (32) different accessions of common beans were used for the field experiment, among which 17 were climbing accessions (Babessi 1, Babessi 2, Boa 5.1 M6, DOR-701, Kabo-6F9-8-27, KJ 4/3, Mac 33, Mac 55, Mac Mbouda, Meringue local, Mex 142, Nuv-109-2, Nuv 6, RWR 2154, RWR 2245, Sénégalaise glissé, Ty-3396-12) and 15 were dwarf accessions (Babessi 3, Banguem, BGG, Ecapan 021, Feb 192, GL22, GLP 190-C, Guzan local, Large white bean, Losakia, Mancha 3, Nitu, NUA 566, PNN, RWR 3194). They were obtained from the IRAD Station of Foumbot. These accessions were selected for their availability and to the fact that they are appreciated for local consumption. A completely randomized block design made up of 32 accessions repeated thrice was used.

The study was conducted at IRAD Dschang Station during two growing seasons (from March to July 2020 and 2021). Dschang is located in the agro-ecological zone of the western highlands of Cameroon. The climate is equatorial monsoon with a mountainous facies determined by the average altitude of 1,400 m. It is characterised by two seasons: a rainy season that lasts from mid-March to mid-November and a dry season from mid-November to mid-March. The annual rainfall is approximately 2,000 mm. Relative humidity is generally above 60%. Dschang receives an average of 2,000 hours of sunshine per year. The soil at the experimental site is sandy loam with a pH of 6.1 (Sanyang, *et al.,* 2019). Sowing was done manually and two seeds were planted per hole. Weeding and mulching were done 1 and 2 months after sowing. Inorganic fertilizer (NPK: 12:06:20) was also applied at a dose of 5 g per plant on a month old plants. Also, climbing accessions were staked one month after planting to help support and direct the climbing stems.

Evaluation of the agronomic traits of common beans accessions

Assessment of the quantitative traits of common bean accessions was focused on: plant height, number of leaves, leave length, 50% flowering, physiological maturity and yield. The yield was calculated using the following formula of Soltner (2003): Yield = (Mgr/ NP) x 10000/D Where: Yield = yield in kg/ha, Mgr = seed mass in kg, NP = number of harvested plants and D = density (number of plants per hectare).

Statistical analysis

The data collected were submitted to analysis of variance (ANOVA) using R software version 4.0 and the means separation was done using the Duncan test (1955) at the probability threshold of 0.05.

Results

The evaluation was carried out using growth, yield and disease variables.

Growth variables

The mean values for plant height, number of leaves and leaf length are shown in Table 1. With regard to plant height, in 2020 significant differences were observed between common bean accessions. In two years of trial (2020 and 2021), the highest average height was obtained with Mac Mbouda (1.16 m) while the lowest was obtained with PNN (0.13 m). In 2021, the highest average height was obtained with Mac Mbouda (1.77 m) while the lowest was obtained with Kabo-6F9-8-2 (0.29 m). In 2020, the highest number of leaves was recorded on NUV-109--2 with an average of 15 leaves, while the lowest average number was obtained on Nitu and Losakia (9 and 9 leaves respectively). In 2021, the highest number of leaves was recorded on DOR-701 with an average of 18 leaves, while the lowest average number was obtained on Babessi 3 with an average of 11 leaves. With regard to leaf length, in 2020 the highest lengths were found on Kabo-6F9-8-27 with an average of 0.33 m and Feb-192 with an average of 0.32 m respectively, while the lowest value was obtained on GLP 190-C (0.24 m). In 2021, the highest leaf length was recorded on PNN with an average of 0.39 m and the lowest on Meringue local with an average of 0.21 m.

Table 1: Plant height, number of leaves and leaves length of bean genotypes in 2020 and 2021

Accession	Plant height (m)		Number of leaves		Leaves lenght (m)	
	2020	2021	2020	2021	2020	2021
Mac 55	0.80±0.14^{c}	1.28±0.49^{de}	15±4^{a}	16±3^{ab}	0.30±0.04^{abcde}	0.27±0.02^{bcd}
Mac Mbouda	1.16±0.30^{a}	1.77±0.60^{a}	13±5^{abcde}	14±3^{cde}	0.28±0.03^{abcdef}	0.27±0.02^{bcdef}
RWR 2154	0.48±0.14^{de}	0.72±0.26^{ghi}	10±1^{fghi}	14±2^{bcd}	0.26±0.03^{efg}	0.27±0.03^{bcd}
Mac 33	0.95±0.16^{b}	1.61±0.52^{ab}	13±2^{abcdef}	15±3^{bcd}	0.29±0.03^{abcdef}	0.27±0.03^{bcdef}
DOR-701	0.40±0.16^{ef}	0.76±0.11^{gh}	13±2^{abcde}	18±6^{a}	0.28±0.04^{bcdef}	0.23±0.03^{ghijk}
Nuv 6	0.87±0.30^{bc}	1.58±0.41^{ab}	13±3^{abcde}	15±3^{bcd}	0.31±0.05^{abc}	0.24±0.07^{fghijk}
Mex 142	0.55±0.25^{d}	1.23±0.64^{de}	15±3^{ab}	15±3^{bc}	0.26±0.06^{efg}	0.24±0.02^{efghij}
Nuv 109 2	0.75±0.33^{c}	1.33±0.47^{cd}	15±3^{a}	14±3^{bcd}	0.26±0.05^{defg}	0.27±0.02^{bcdef}
RWR 2245	0.46±0.13^{de}	0.63±0.26^{hij}	13±4^{abcde}	15±3^{bcd}	0.26±0.04^{efg}	0.25±0.04^{cdefghi}
KJ4/3	0.57±0.24^{d}	0.91±0.38^{fg}	12±2^{bcdefg}	15±3^{bcd}	0.29±0.04^{abcdef}	0.22±0.03^{ijk}
Babessi 2	0.51±0.22^{de}	1.10±0.33^{ef}	13±3^{abcde}	13±2^{cde}	0.30±0.05^{abcd}	0.23±0.03^{hijk}
RWR 3194	0.25±0.05^{hij}	0.42±0.08^{jkl}	10±2^{hi}	13±2^{cde}	0.28±0.04^{abcdef}	0.28±0.06^{b}
BOA 5.1 M6	0.39±0.12^{efg}	0.54±0.12^{ijk}	15±1^{ab}	13±3^{cde}	0.28±0.03^{bcdef}	0.21±0.02^{jk}
FEB-192	0.26±0.04^{hij}	0.41±0.05^{jkl}	11±2^{efghi}	12±3de	0.32±0.04^{ab}	0.27±0.04^{bcd}
Sénégal glissé	0.45±0.31^{de}	0.39±0.05^{jkl}	12±2^{defgh}	15±3^{bc}	0.28±0.05^{bcdef}	0.24±0.04^{defghi}
Babessi 1	0.45±0.25^{de}	1.50±0.48^{bc}	10±2^{ghi}	13±3^{cde}	0.30±0.04^{abcde}	0.26±0.02^{bcdefg}
Large white	0.25±0.10^{hij}	0.34±0.08^{kl}	10±1^{hi}	13±3^{cde}	0.28±0.04^{bcdef}	0.27±0.03^{bc}
Guzan local	0.22±0.05^{hij}	0.38±0.08^{kl}	10±4^{fghi}	12±4de	0.30±0.06^{abcde}	0.25±0.04^{defghi}
Meringue loca	0.17±0.5^{ij}	0.41±0.16^{jkl}	14±2^{abc}	15±3^{bcd}	0.30±0.05^{abcde}	0.21±0.02^{k}
Ecapan 021	0.25±0.05^{hij}	0.48±0.07^{jkl}	11±2^{efghi}	14±3^{bcd}	0.28±0.04^{bcdef}	0.27±0.03^{bcd}
Ty-3396-12	0.15±0.05^{ij}	0.45±0.16^{jkl}	13±2^{abcdef}	13±2^{cde}	0.26±0.03^{gf}	0.27±0.03^{bcd}
Nitu	0.22±0.05^{hij}	0.40±0.08^{jkl}	9±2^{i}	12±2de	0.29±0.06^{abcdef}	0.25±0.03^{cdefghi}
Mancha 3	0.20±0.04^{hij}	0.33±0.05^{kl}	11±3^{efghi}	14±4^{cde}	0.28±0.05^{bcdef}	0.26±0.03^{bcdefgh}
GLP 190 C	0.28±0.14^{fghi}	0.45±0.08^{jkl}	12±3^{cdefgh}	13±3^{cde}	0.24±0.05^{g}	0.25±0.04^{bcdefghi}
NUA 566	0.27±0.06^{ghi}	0.42±0.07^{jkl}	10±2^{hi}	13±2^{cde}	0.28±0.06^{bcdef}	0.27±0.03^{bcd}
BGG	0.21±0.06^{hij}	0.35±0.07^{kl}	13±3^{abcdef}	14±3^{bcd}	0.28±0.03^{abcdef}	0.23±0.02^{ghijk}
Banguem	0.32±0.06^{fgh}	0.45±0.09^{jkl}	11±3^{efghi}	13±2^{cde}	0.31±0.03^{abc}	0.27±0.05^{bcd}
Babessi 3	0.23±0.08^{hij}	0.31±0.05^{kl}	13±5^{abcdef}	11±3^{e}	0.28±0.04^{cdefg}	0.25±0.04^{cdefghi}
PNN	0.13±0.04^{j}	0.46±0.10^{jkl}	14±3^{abc}	15±3^{bcd}	0.29±0.05^{abcdef}	0.39±0.04^{a}
Kabo-6F9-8-2	0.18±0.8^{hij}	0.29±0.6^{l}	14±5^{abcd}	13±3^{cde}	0.33±0.08^{a}	0.27±0.05^{bcde}
Losakia	0.19±0.05^{hij}	0.35±0.05^{kl}	9±1^{i}	13±3^{cde}	0.32±0.03^{abc}	0.25±0.03^{cdefghi}
GL22	0.23±0.11^{hij}	0.34±0.06^{kl}	10±3^{hi}	14±4^{cde}	0.30±0.03^{abcde}	0.23±0.03^{ghijk}
Mean	0.40	0.70	12	14	0.28	0.26
CV	40.32	39.17	23.72	22.14	16.02	13.06
P (Accession)	2.2^{e-16}***	2.2^{e-16}***	2.2^{e-16}***	1.002^{e-08}***	7.429^{e-13}***	2.2^{e-16}***

Means assigned the same letter in the same column are not significantly different according to the Duncan test at the 5% probability threshold. Signification after ANOVA test : *** P < 0.001, very highly significant; ** P < 0.01, highly significant; * P < 0.05, significant; P≥0.05, not significant.

Time (days) to reach 50% flowering, 50% maturity and yield

Time (days) to reach 50% flowering

In 2020, significant differences were obtained for the variable "time to 50% flowering" among the means of bean accessions. The highest value was recorded on Babessi 1 with 49 DAS while the lowest were observed on Nitu, Guzan local, Babessi 3, Mancha 3 and Losakia with values ranging from 34 to 35 DAS.

In 2021, the highest value of "time to 50% flowering" was recorded on Meringue local with 48 DAS, while Nitu, Losakia, Mancha 3 and Guzan local gave the lowest values, namely 36; 36; 36 and 35 DAS respectively (Table 2).

The average data obtained over the two years of trials show that of the 32 bean accessions tested, Nitu, Losakia, Mancha 3 and local Guzan can be considered the earliest.

Time (days) to reach 50% maturity

Significant differences at a 0.05 % probability threshold for the variable « time to 50% maturity » were noted in both years of trial. In 2020, the highest value was recorded on Mex 142 with 91 DAS while the lowest were observed on Guzan local, Nitu and Mancha 3 with values of 69, 69 and 71 DAS respectively. In 2021, the highest value was recorded on Meringue local with 87 DAS, while the lowest values were obtained on Mancha 3, Nitu, Guzan local, Babessi 3 and Losakia with values ranging from 72 to 73 DAS (Table 2).

Yields

Significant differences at 0.05% probability level were found for bean yields in both years of trial. Accession MAC 55 had the highest value in 2020 and 2021 with an average yield of 4.57 $t.ha^{-1}$ and 3.66 $t.ha^{-1}$ respectively. Accessions GL22 and Kabo-6F9-8-27 gave the lowest yields in both years of trial, with mean values of 0.95 $t.ha^{-1}$ and 0.7 $t.ha^{-1}$ respectively (Table 2).

Table 2: Time (days) to 50% flowering, 50% pod maturity and yields of bean accessions in 2020 and 2021

Accession	50 % flowering (days)		50 % maturity (days)		Yields ($t.ha^{-1}$)	
	2020	2021	2020	2021	2020	2021
Mac 55	43 ± 1^{cdef}	42 ± 1^{cdef}	82 ± 2^{bc}	85 ± 4^{abcd}	4.57 ± 0.11^{a}	3.66 ± 1.19^{a}
Mac Mbouda	42 ± 2^{cdefgh}	40 ± 1^{defghij}	79 ± 1^{cdef}	85 ± 1^{abc}	4.17 ± 0.80^{ab}	2.42 ± 1.21^{abcdefg}
RWR 2154	40 ± 1^{defghi}	40 ± 2^{cdefghi}	70 ± 1^{l}	76 ± 5^{fghi}	3.84 ± 2.44^{abc}	2.18 ± 0.57^{bcdefg}
Mac 33	43 ± 1^{cdef}	40 ± 2^{defghij}	81 ± 2^{bcd}	82 ± 6^{abcdef}	3.67 ± 0.87^{abcd}	2.30 ± 0.44^{bcdefg}
DOR-701	42 ± 2^{cdefgh}	41 ± 5^{cdefgh}	75 ± 2^{hij}	73 ± 3^{ghi}	3.63 ± 1.02^{abcd}	2.66 ± 0.78^{abcde}
Nuv 6	43 ± 1^{cdefg}	46 ± 0^{ab}	71 ± 1^{kl}	77 ± 2^{efghi}	3.53 ± 0.31^{abcde}	3.28 ± 0.88^{ab}
Mex 142	46 ± 2^{abc}	41 ± 2^{cdefg}	91 ± 1^{a}	86 ± 4^{abc}	3.38 ± 0.66^{abcdef}	1.82 ± 0.78^{cdefgh}
Nuv 109 2	$42\pm^{cdefgh}$	42 ± 3^{bcdef}	78 ± 1^{defg}	80 ± 4^{bcdefg}	3.29 ± 1.34^{bcdefg}	2.55 ± 0.54^{ab}
RWR 2245	36 ± 3^{ij}	40 ± 3^{defghij}	76 ± 0^{ghi}	82 ± 6^{abcdef}	2.91 ± 0.61^{bcdefgh}	2.56 ± 1.34^{abcdef}
KJ4/3	42 ± 2^{cdefgh}	39 ± 3^{defghijk}	76 ± 4^{ghi}	78 ± 6^{defghi}	2.89 ± 0.57^{cdefgh}	1.08 ± 0.33^{gh}
Babessi 2	45 ± 1^{abcd}	40 ± 1^{defghij}	82 ± 1^{bc}	86 ± 3^{ab}	2.79 ± 0.60^{cdefghi}	1.97 ± 0.18^{bcdefgh}
RWR 3194	38 ± 1^{fghij}	37 ± 0^{ghijk}	77 ± 2^{fghi}	76 ± 1^{fghi}	2.75 ± 0.68^{cdefghi}	2.87 ± 0.88^{abc}
BOA 5,1 M6	44 ± 2^{abcde}	40 ± 1^{defghij}	82 ± 1^{b}	77 ± 4^{efghi}	2.74 ± 0.65^{cdefghi}	1.82 ± 0.28^{cdefgh}
FEB-192	37 ± 1^{ghij}	37 ± 0^{ghijk}	76 ± 1^{ghij}	74 ± 1^{ghi}	2.67 ± 0.27^{cdefghi}	2.02 ± 0.32^{bcdefgh}
Sénégal glissé	43 ± 2^{bcdef}	39 ± 1^{defghijk}	82 ± 0^{bc}	83 ± 4^{abcde}	2.57 ± 0.69^{cdefghij}	1.93 ± 0.55^{bcdefgh}
Babessi 1	49 ± 1^{a}	43 ± 5^{bcd}	77 ± 3^{efgh}	76 ± 1^{fghi}	2.44 ± 0.75^{defghij}	2.01 ± 0.18^{bcdefgh}
Large white bea	36 ± 1^{ij}	38 ± 1^{efghijk}	74 ± 1^{ij}	76 ± 1^{fghi}	2.42 ± 0.93^{defghijk}	2.62 ± 0.94^{abcdef}
Guzan local	34 ± 0^{j}	35 ± 0^{k}	69 ± 2^{l}	73 ± 5^{hi}	2.42 ± 0.97^{defghijk}	1.40 ± 1.21^{efgh}
Meringue local	48 ± 1^{ab}	48 ± 0^{a}	82 ± 1^{b}	87 ± 1^{a}	2.35 ± 0.46^{defghijk}	2.28 ± 0.69^{bcdefg}
Ecapan 021	39 ± 1^{efghij}	37 ± 2^{ghijk}	78 ± 1^{defg}	73 ± 3^{ghi}	2.30 ± 0.57^{efghijk}	2.73 ± 0.44^{abcd}
Ty-3396-12	47 ± 1^{abc}	44 ± 4^{abc}	79 ± 1^{cdef}	79 ± 3^{cdefgh}	2.11 ± 0.32^{fghijkl}	2.49 ± 0.33^{abcdef}
Nitu	34 ± 1^{j}	36 ± 1^{jk}	69 ± 1^{l}	72 ± 4^{i}	1.99 ± 0.28^{ghijkl}	2.00 ± 0.79^{bcdefgh}
Mancha 3	34 ± 1^{ij}	36 ± 1^{jk}	71 ± 1^{kl}	72 ± 3^{i}	1.97 ± 0.17^{ghijfl}	1.49 ± 0.53^{defgh}
GLP 190 C	36 ± 1^{ij}	39 ± 5^{defghijk}	75 ± 3^{hij}	76 ± 2^{fghi}	1.93 ± 0.37^{hijkl}	2.17 ± 0.74^{bcdefg}
NUA 566	36 ± 1^{ij}	37 ± 0^{ghijk}	75 ± 2^{ij}	75 ± 1^{fghi}	1.91 ± 0.27^{hijkl}	1.67 ± 0.17^{cdefgh}
BGG	36 ± 1^{ij}	36 ± 1^{ijk}	75 ± 1^{hij}	73 ± 3^{ghi}	1.69 ± 0.81^{hijkl}	2.22 ± 0.40^{bcdefg}
Banguem	38 ± 2^{fghij}	38 ± 1^{fghijk}	78 ± 1^{efgh}	76 ± 1^{fghi}	1.64 ± 0.35^{hijkl}	1.90 ± 0.38^{cdefgh}
Babessi 3	34 ± 0^{j}	37 ± 1^{hijk}	73 ± 2^{jk}	73 ± 3^{hi}	1.55 ± 0.28^{ijkl}	1.99 ± 0.38^{bcdefgh}
PNN	46 ± 0^{abc}	42 ± 5^{bcde}	80 ± 1^{bcde}	78 ± 3^{efghi}	1.32 ± 0.35^{jkl}	1.28 ± 0.08^{efgh}
Kabo-6F9-8-2	37 ± 14^{hij}	43 ± 0^{bcd}	79 ± 2^{cdef}	79 ± 5^{cdefgh}	1.30 ± 0.41^{jkl}	0.71 ± 0.36^{h}
Losakia	35 ± 1^{ij}	36 ± 1^{jk}	74 ± 0^{ij}	73 ± 3^{hi}	1.11 ± 0.46^{kl}	1.52 ± 0.68^{cdefgh}
GL22	35 ± 1^{ij}	37 ± 0^{ghijk}	75 ± 1^{ij}	$74\pm2.^{ghi}$	0.95 ± 0.25^{l}	1.25 ± 0.18^{fgh}
Means	40	39	77	78	2.5	2.09
Variation coef	6.94	5.76	1.91	4.49	26.49	32.69
P (Accession)	2.96^{e-12}***	2.34^{e-09}***	2^{e-16}***	1.38^{e-08}***	6.38^{e-09}***	0.0009***

Means assigned the same letter in the same column are not significantly different according to the Duncan test at the 5% probability threshold. Signification after ANOVA test : *** P < 0.001, very highly significant; ** P < 0.01, highly significant; * P < 0.05, significant; P≥0.05, not significant.

Disease Variables

Disease variables were assessed according to two criteria: disease incidence and disease severity.

Disease incidence

Angular leaf spot (ALS)

In 2020, significant differences were found for disease incidence among bean accessions. The highest incidence (93.33 to 100%) were recorded on more than half of the accessions tested, while the lowest incidence was recorded on BOA 5.1M6 (0%).

In 2021, ANOVA showed no significant difference at $p<0.05\%$ probability level for disease incidence among common bean accessions (Table 3).

Floury leaf spot (FLS)

In 2020, significant differences were detected for FLS incidence among common bean accessions. The highest incidence (100%) was recorded on 13 of the 32 accessions, while Nuv 6 and Lokasia had the lowest incidence (6.67% and 6.67%).

In 2021, significant differences were detected for FLS incidence among common bean accessions. The highest incidence was recorded on Banguem and RWR 3194 with 100% each, while the lowest incidence values (0% to 26.67%) were recorded on 19 of the 32 bean accessions (Table 3). Banguem and RWR 3194 were among those with the highest FLS incidence in both years while Losakia was among those with the lowest incidence in 2020 and 2021.

Rust

In 2020, highly significant differences were detected for incidence among bean accessions. The highest incidence values were recorded on Babessi 1 and Kabo-6F9-8-27 with 80% each. The lowest incidence values were obtained on twenty accessions, including Mac 55, Nuv-109-2, Sénégalaise glissé, Babessi 2, BOA 5.1 M6, MAC 33, Mac Mbouda, Mex 142, NUV 6, RWR 2154, RWR 2245, Ty 3396-12 and others, with values ranging from 0.00% to 13.33%.

In 2021, the highest incidence values were recorded on DOR-701 and Kabo-6F9-8-27 with 100% each. The lowest incidence values were obtained on Babessi 2, BOA 5.1 M6, MAC Mbouda Mex 142, Sénégalaise glissé and Ty 3396-12, Nuv 6, RWR 3194, Feb 192, Ecapan 021, Nua 566, Banguem, and PNN with values ranging from 0.00% to 6.67% (Table 3). Kabo-6F9-8-27 was among those with the highest rust incidence in both years of the trial, while many accessions showed 0% rust incidence in both years. Thus, rust proved to be a fungal disease that did not represent a significant threat in the study area.

Table 3: Incidence (%) of ALS, FLS and rust in common bean accessions in 2020 and 2021

Accessions	ALS				Rust	
	2020	2021	FLS 2020	FLS 2021	2020	2021
Mac 55	46.67±41.63^{bc}	100.00±0.00^{a}	86.67±11.55^{abc}	6.67±11.55^{b}	13.33±23.09^{c}	13.33±23.09^{cd}
Mac Mbouda	100.00±0.00^{a}	100.00±0.00^{a}	26.67±23.09^{fg}	0.00±0.00^{b}	0.00±0.00^{c}	0.00±0.00^{d}
RWR 2154	100.00±0.00^{a}	100.00±0.00^{a}	100.00±0.00^{a}	33.33±57.73^{ab}	0.00±0.00^{c}	13.33±11.55^{cd}
Mac 33	73.33±46.19^{ab}	100.00±0.00^{a}	100.00±0.00^{a}	33.33±57.73^{ab}	0.00±0.00^{c}	20.00±20.00^{cd}
DOR-701	100.00±0.00^{a}	100.00±0.00^{a}	100.00±0.00^{a}	0.00±0.00^{b}	46.67±50.33^{abc}	100.00±0.00^{a}
Nuv 6	100.00±0.00^{a}	100.00±0.00^{a}	6.67±11.55^{g}	0.00±0.00^{b}	0.00±0.00^{c}	6.67±11.55^{d}
Mex 142	100.00±0.00^{a}	100.00±0.00^{a}	73.33±11.55^{abcd}	0.00±0.00^{b}	0.00±0.00^{c}	0.00±0.00^{d}
Nuv 109 2	100.00±0.00^{a}	100.00±0.00^{a}	46.67±11.55^{cdef}	33.33±57.73^{ab}	6.67±11.55^{c}	46.67±30.55^{abcd}
RWR 2245	100.00±0.00^{a}	100.00±0.00^{a}	100.00±0.00^{a}	26.67±46.19^{b}	0.00±0.00^{c}	20.00±20.00^{cd}
KJ4/3	46.67±30.55^{bc}	100.00±0.00^{a}	93.33±11.55^{ab}	0.00±0.00^{b}	33.33±57.73^{abc}	33.33±30.55^{bcd}
Babessi 2	80±34.64^{ab}	100.00±0.00^{a}	66.67±11.55^{abcde}	0.00±0.00^{b}	0.00±0.00^{c}	0.00±0.00^{d}
RWR 3194	60.00±20.00^{abc}	100.00±0.00^{a}	100.00±0.00^{a}	100.00±0.00^{a}	6.67±11.55^{c}	6.67±11.55^{d}
BOA 5,1 M6	0.00±0.00^{d}	100.00±0.00^{a}	100.00±0.00^{a}	0.00±0.00^{b}	0.00±0.00^{c}	0.00±0.00^{d}
FEB-192	93.33±11.55^{a}	100.00±0.00^{a}	93.33±11.55^{ab}	0.00±0.00^{b}	33.33±57.73^{abc}	0.00±0.00^{d}
Sénégalai glissé	93.33±11.55^{a}	100.00±0.00^{a}	66.67±57.73^{abcde}	0.00±0.00^{b}	6.67±11.55^{c}	0.00±0.00^{d}
Babessi 1	73.33±30.55^{ab}	100.00±0.00^{a}	40.00±34.64^{defg}	26.00±46.19^{b}	80.00±34.64^{a}	66.67±57.73^{abc}
Large white bea	100.00±0.00^{a}	100.00±0.00^{a}	100.00±0.00^{a}	20.00±20.00^{b}	33.33±30.55^{abc}	33.33±57.73^{bcd}
Guzan local	80±20.00^{ab}	100.00±0.00^{a}	100.00±0.00^{a}	66.67±57.73^{ab}	33.33±30.55^{abc}	66.67±41.63^{abc}

Meringue loca	86.67±23.09^{ab}	100.00±0.00^{a}	33.33±30.55^{efg}	0.00±0.00^{b}	40.00±52.91^{abc}	53.33±30.55^{abcd}
Ecapan 021	100.00±0.00^{a}	100.00±0.00^{a}	100.00±0.00^{a}	66.67±57.73^{ab}	6.67±11.55^{c}	0.00±0.00^{d}
Ty-3396-12	93.33±11.55^{a}	100.00±0.00^{a}	66.67±57.73^{abcde}	33.33±57.73^{ab}	0.00±0.00^{c}	0.00±0.00^{d}
Nitu	73.33±30.55^{ab}	100.00±0.00^{a}	93.33±11.55^{ab}	66.67±57.73^{ab}	0.00±0.00^{c}	13.33±23.09^{cd}
Mancha 3	100.00±0.00^{a}	100.00±0.00^{a}	93.33±11.55^{ab}	0.00±0.00^{b}	26.67±11.55^{bc}	66.67±57.73^{abc}
GLP 190 C	93.33±11.55^{a}	100.00±0.00^{a}	86.67±23.09^{abc}	66.67±57.73^{ab}	40.00±34.64^{abc}	26.67±46.19^{bcd}
NUA 566	93.33±11.55^{a}	100.00±0.00^{a}	100.00±0.00^{a}	53.33±50.33^{ab}	0.00±0.00^{c}	6.67±11.55^{d}
BGG	93.33±11.55^{a}	100.00±0.00^{a}	100.00±0.00^{a}	66.67±57.73^{ab}	20.00±34.64^{bc}	26.67±30.55^{bcd}
Banguem	33.33±11.55^{cd}	100.00±0.00^{a}	100.00±0.00^{a}	100.00±0.00^{a}	0.00±0.00^{c}	0.00±0.00d
Babessi3	93.33±11.55^{a}	100.00±0.00^{a}	100.00±0.00^{a}	66.67±57.73^{ab}	0.00±0.00^{c}	66.67±57.73^{abc}
PNN	86.67±23.09^{ab}	100.00±0.00^{a}	80±34.64^{abc}	0.00±0.00^{b}	0.00±0.00^{c}	0.00±0.00^{d}
Kabo-6F9-8-2	86.67±23.09^{ab}	100.00±0.00^{a}	53.33±41.63^{bcdef}	0.00±0.00^{b}	80.00±34.64^{a}	100.00±0.00^{a}
Losakia	73.33±46.19^{ab}	100.00±0.00^{a}	6.67±11.55^{g}	0.00±0.00^{b}	66.67±41.63^{ab}	80±34.64^{ab}
GL22	73.33±23.06^{ab}	100.00±0.00^{a}	100.00±0.00^{a}	0.00±0.00^{b}	0.00±0.00^{c}	53.33±50.33^{abcd}
Means	82.08	100.00	78.54	27.08	17.92	28.75
Variation coef.	25.81	7.10^{e-14}	26.89	131.20	145.01	101.75
P (Accession)	9.185^{e-06}***	0.486	3.56^{e-09}***	0.0012**	0.000415***	1.51^{e-05}***

Means assigned the same letter in the same column are not significantly different according to the Duncan test at the 5% probability threshold. Signification after ANOVA test : *** P < 0.001, very highly significant; ** P < 0.01, highly significant; * P < 0.05, significant; P≥0.05, not significant.

Disease Severity

Angular leaf spot (ALS)

In 2020, highly significant differences were detected among common bean accessions. The highest severity values were recorded on Nuv 6, DOR-701 and RWR 2154 with 56.67%, 53.33% and 50.00% respectively, while the lowest severity value was recorded on Boa5.1M6 (0.00%). It should be noted that all these accessions were climbers. Among the dwarf accessions, the highest severity values were recorded on PNN, Mancha 3 and GLP 190-C with 46.43%, 45.0 and 44.64% respectively.

In 2021, significant differences were also noted for ALS severity among bean accessions. The highest severity values were recorded on Mancha 3, Babessi 3, Guzan local and Nitu with 68.33%, 63.33, 63.33 and 58.33% respectively while the lowest severity value was obtained with Mac 55 (25%) (Fig. 1). Climbing accessions susceptible to ALS generally had higher severity values in 2020 than in 2021, while climbing accessions resistant to ALS had higher values on average in 2021 than in 2020. Mancha 3, PNN, DOR-701 and Mex 142 were among the most susceptible accessions in both years (with a severity of more than 50%), while Banguem, RWR 3194, BOA 5.1 M6, Mac 33 and Mac 55 were among the most resistant accessions in 2020 and 2021 (with a severity of less than 10%), (Fig. 1).

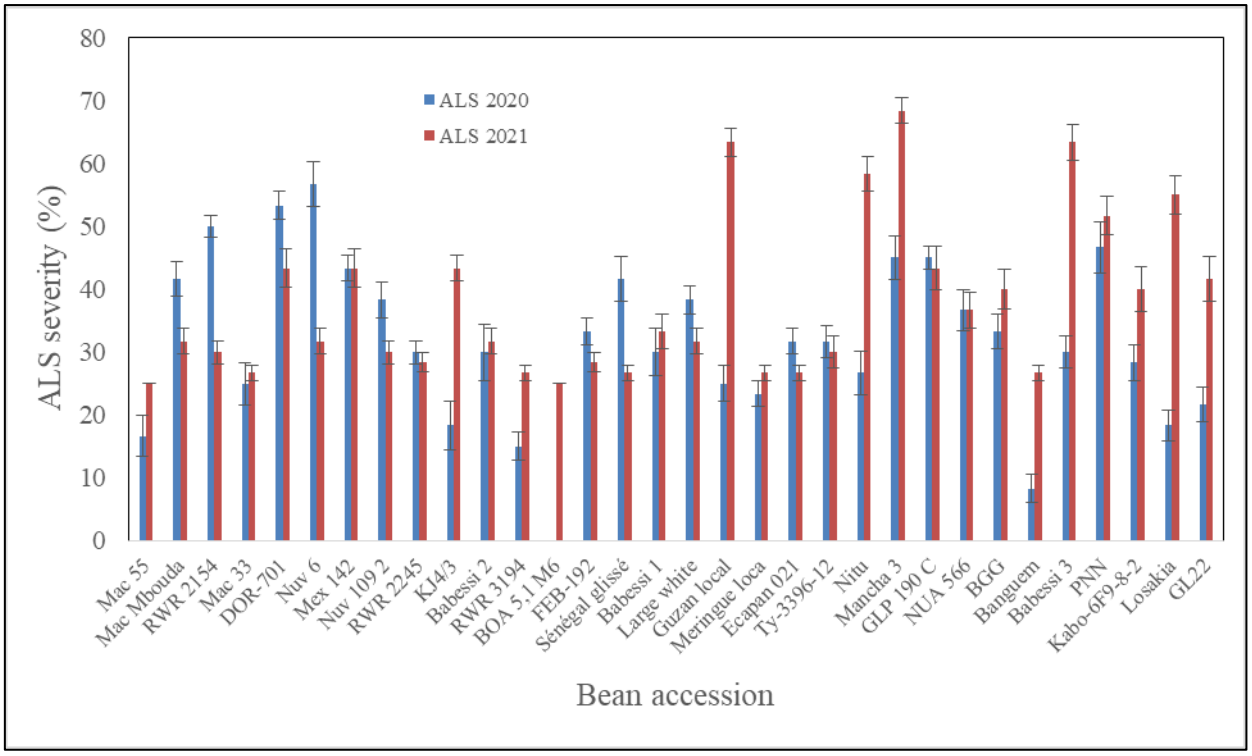

Figure 1: Severity of angular leaf spot in bean accessions

Floury Leaf Spot (FLS)

In 2020, highly significant differences were observed for severity among bean accessions for FLS. The highest severity values were recorded on Guzan local, Banguem, Large white bean, RWR 3194 and Ecapan 021 (all dwarf accessions) with 56.67%, 53.33%, 53.33%, 53.33% and 51.67% respectively while the lowest severity values were found on Losakia and Nuv 6 (1.92% and 3.33% respectively).

In 2021, ANOVA also showed a highly significant difference ($P<0.001$) in severity among the dwarf accessions. The highest severity values were recorded on RWR 3194, Banguem, Babassi 3 with 48.33%, 45.00% and 36.67% respectively while the lowest severities were obtained on Babessi 2, Boa 5. 1 M6, DOR-701, Kabo-6F9-8-27, KJ 4/ 3, MAC Mbouda, Meringue locale, Mex 142, NUV-6, Sénégalaise glissé, GL22, Feb-192, Losakia, Mancha 3 and PNN all with 0.00% (Fig. 2)

In general, severity of FLS was higher in 2020 than in 2021. Banguem and RWR 3194 were among the most susceptible accessions in both years of trials (with severity above 50%), while Losakia, Mac Mbouda, Meringue locale and NUV 6 were among the most resistant accessions (with severity below 10%).

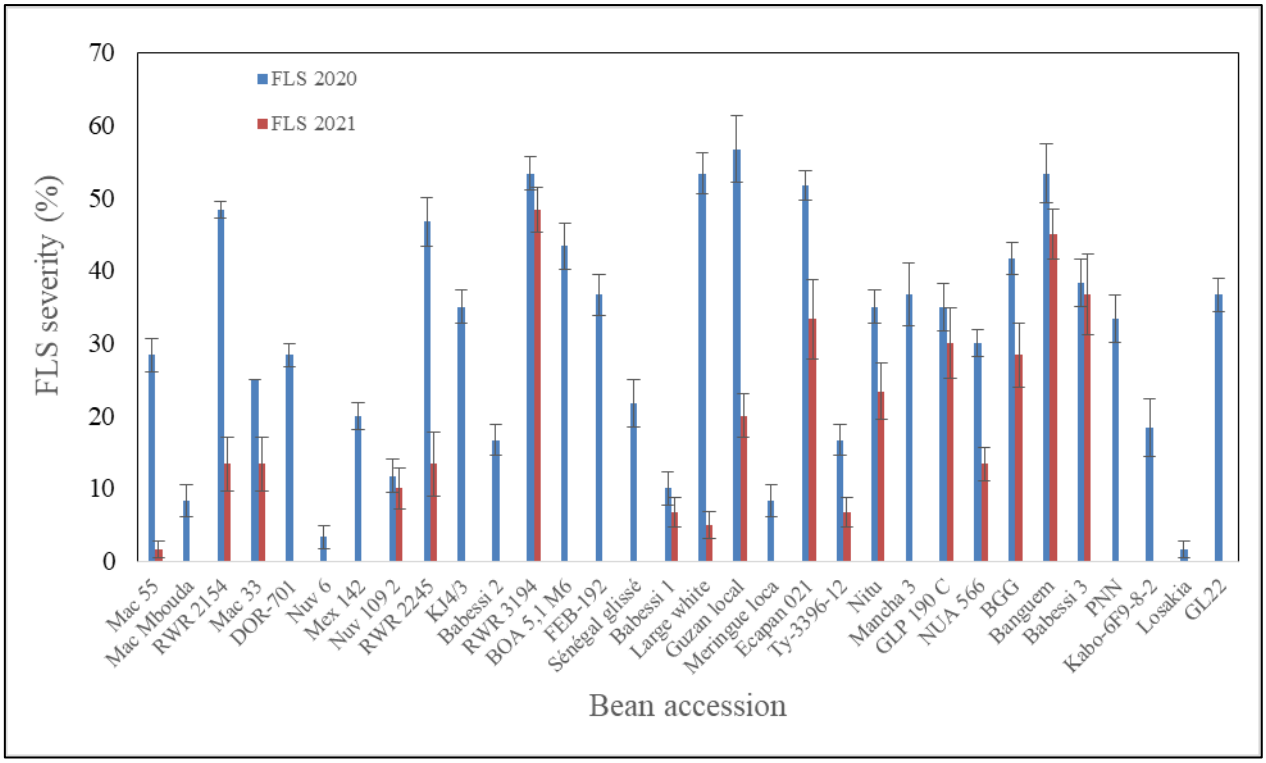

Figure 2: Severity of floury spot disease in bean accessions

Rust

In 2020, highly significant differences were found for rust severity among common bean accessions. The highest values were recorded on Kabo-6F9-8-27, Babessi 1 and Lokasia with 28.33% and 23.33% respectively, while the lowest severities were recorded on Ecapan 021, RWR 3194, GL22, Babessi, Banguem, Nitu, Nua 566, PNN, NUV-109-2, NUV 6, Sénégalaise glissé, Babessi 2, Boa 5. 1 M6, Mac 33, MAC Mbouda, Mex 142, RWR 2154, RWR 2245 and Ty-3396-12 with values ranging from 1.67% to 0%.

In 2021, very highly significant differences were also observed at $p<0.05$ threshold, with the highest severity values obtained with accessions Kabo-6F9-8-27, Babessi 1 and Guzan local with 55.00% and 47.27% respectively. The lowest severities were recorded on NUV-6, Babessi 2, Boa 5. 1 M6, MAC Mbouda, Mex 142, Sénégalaise glissé and Ty-3396-12, Nitu, NUA 566, RWR 3194, Banguem, Ecapan 021, Feb 192 and PNN with values ranging from 1.67 to 0% (Fig. 3).

In general, the most susceptible accessions had higher rust severity values in 2021 than in 2020, while the most resistant accessions had similar values in 2020 and 2021.

Several of the accessions, including BOA 5.1 M6, Banguem, Mex 142, Mac Mbouda, Babassi 2 and PNN were not affected by rust (0%) during the two years of the trial.

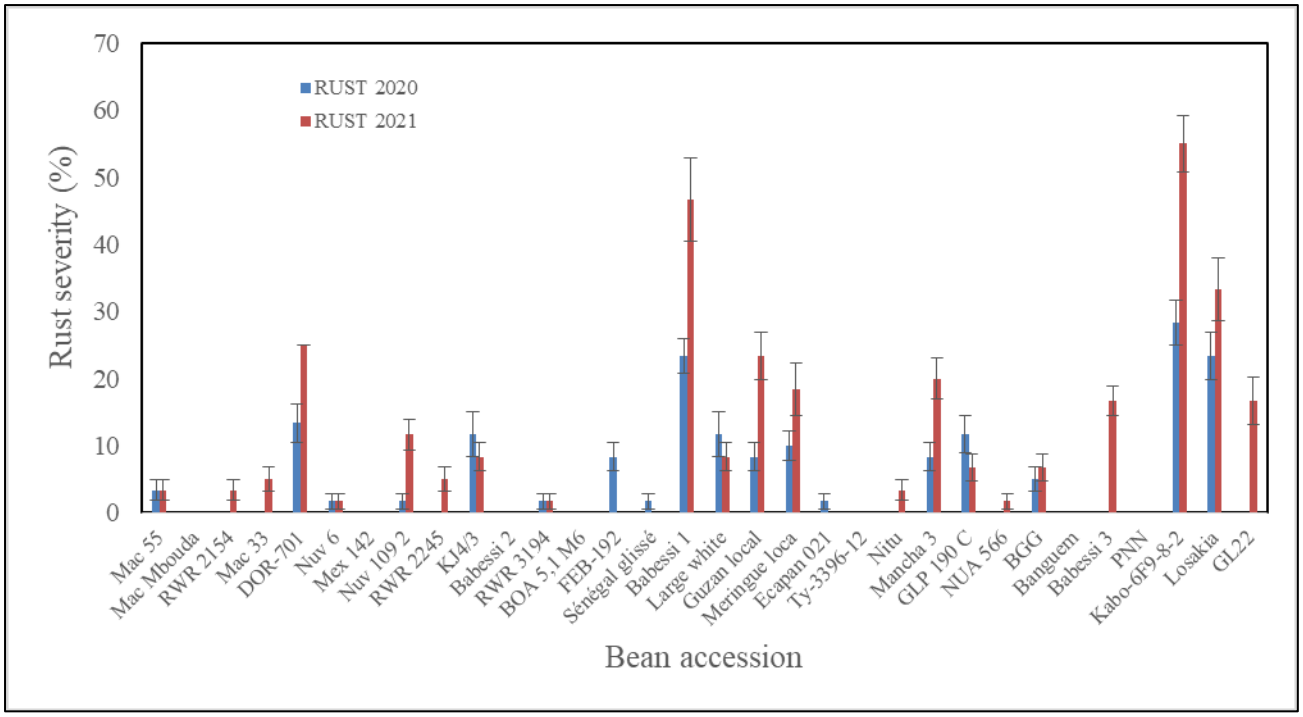

Figure 3: Rust severity in common bean accessions

Comparative Severity of the Three Fungal Diseases of Beans in 2020 and 2021

Figure 4 shows that in 2020, two fungal diseases were dominant, namely ALS and FLS. Some accessions were more susceptible to ALS with a severity of more than 50%, namely RWR 2154, DOR-701 and Nuv 6. Others were more sensitive to FLS (above 50%), namely Guzan local, Large white bean, RWR 3194, Banguem and Ecapan 021. Mac 55, Mac 33 and Meringue Local were among the accessions with the lowest severity for the 3 fungal diseases identified.

A comparative study of the severity of ALS, FLS and rust in 2021 showed that ALS had a severity above 20% on all the 32 accessions studied, FLS and rust had a severity value above 20% on 8 among the 32 accessions (Fig. 5).

In general, rust had the lowest severity in comparison to ALS and FLS in both years (Fig. 4 and 5). This confirms that ALS is the most severe fungal disease observed in the field.

Several of the accessions, including BOA 5.1 M6, Banguem, Mex 142, Mac Mbouda, Babassi 2 and PNN were not affected by rust during the two years of trial (0% severity), while Kabo 6Fg-8-27 (55.00%) and Babessi 1 (46.67%) were the most affected.

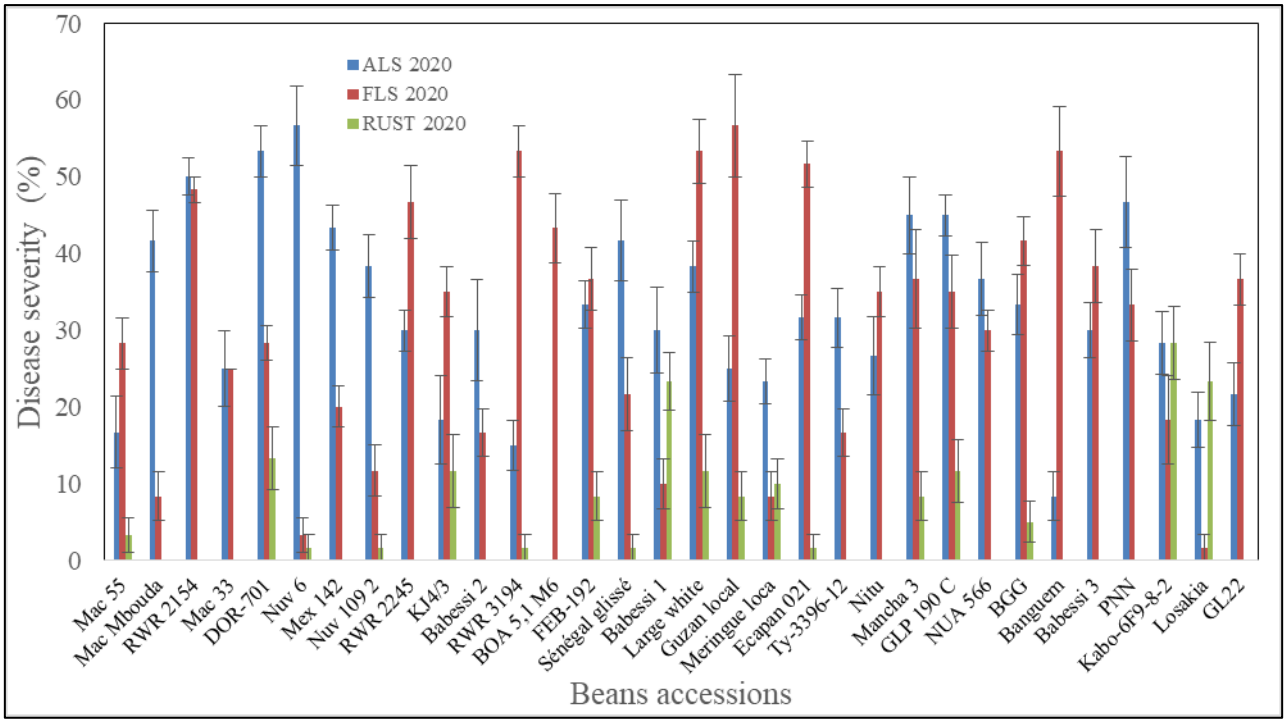

Figure 4: Severity of ALS, FLS and rust in 2020

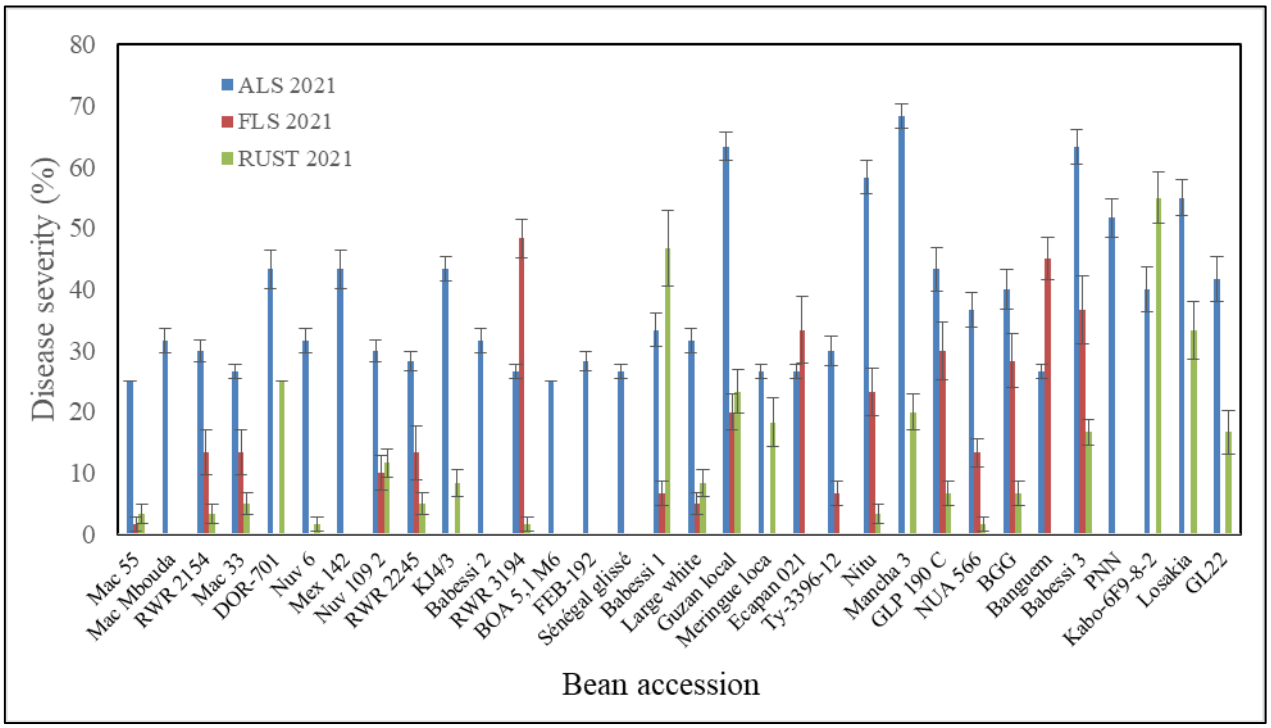

Figure 5: Severity of ALS, FLS and rust in 2021

Discussion

Varietal Resistance to Fungal Diseases in Common Bean

The time required to reach 50% flowering and 50% physiological maturity ranged from 33 to 48 DAS and 41 to 82 DAS, respectively. These results are consistent with the findings of González, *et al.,* (2016) who had determinate-growing cultivars of common bean that generally flowered and matured earlier. It was also observed that the fastest accessions to achieve 50% flowering were the first to reach 50% physiological maturity. These results corroborate those of Zilio, *et al.,* (2013) who found that genotypes with the shortest emergence-flowering period were the earliest to mature. The effect of accession on time to 50% flowering and time to 50%

maturity was statistically significant for all accessions, both dwarf and climbing. It is observed that the time to 50% flowering varies from 35 to 46 DAS and the time to 50% maturity varies from 73 to 88 DAS, considering all the accessions present in the trial. The result of the time to 50% flowering in this study are different from those of Diaw (2002), who found in ttheir experiment that flowering takes place between 24 and 42 DAS. On the other hand, our results for the number of days to 50% maturity are in line with those of Diaw (2002) who found that seed maturation lasts from 60 to 130 days. The differences observed with regard to the number of days to flowering could be explained by the different climatic conditions at the trial sites. Accessions Guzan local, Nitu and RWR 2245 were the earliest, reaching 50% flowering between 34 and 36 DAS, while accessions PNN, Babessi 1 and Meringue local were the latest, reaching 50% flowering between 46 and 48 DAS in the years 2020 and 2021. These results are consistent with the findings of Teckle, *et al.,* (2014) who evaluated common bean accessions, for yield and yield components and found duration at 50 days to flowering between 43 and 61 DAS.

Regarding the yields, results showed that for the years 2020 and 2021, among the dwarf accessions, RWR 3194 had the highest average values (2.75 $t.ha^{-1}$ and 2.87 $t.ha^{-1}$ respectively) while GL22 was among the accessions with the lowest yields (0.95 $t.ha^{-1}$ and 1.25 $t.ha^{-1}$ respectively). Concerning the climbing accessions, MAC 55 had the highest value with an average yield of 4.57 $t.ha^{-1}$ and 3.66 $t.ha^{-1}$ respectively, while Kabo-6F9-8-27 had the lowest yield with a value of 1.30 $t.ha^{-1}$ and 0.71 $t.ha^{-1}$ for the two years respectively. These results corroborate the reports of Gereziher, *et al.,* (2017) who obtained the highest yields with the variety Nasir (2.76 $t.ha^{-1}$) followed by the accessions Alpine (2.47 $t.ha^{-1}$) and Awash Melka (2.15 $t.ha^{-1}$) among 12 accessions.

Concerning the diseases, results obtained on the incidence and severity showed that angular leaf spot was the most severe and afffected all the accessions tested, followed by floury leaf spot and rust. These results are consistent with the findings of Wortmann, *et al.,* (1998) who stated that angular leaf spot is the most important and widespread of the biotic stresses affecting bean production in Africa. The incidence and severity of these diseases depended on the accession and the stage of development of the plant and it was generally observed in 2021 that dwarf accessions were more susceptible to fungal diseases than climbing accessions. These results corroborate those of Djeugap, *et al.,* (2014). This may be due to the fact that most of the agents responsible for fungal diseases persist in the soil and plant debris. The resistance of climbing accessions to fungal diseases can be explained by the fact that their above-ground biomass is quite far from the soil, unlike dwarf accessions. The study on varietal resistance revealed differences in behaviour between the different accessions, hence the interest in a more detailed genetic characterisation that could highlight the proximity or remoteness of the different variables studied in the expression of the different traits.

Conclusion

The general objective of this work was to improve common bean productivity in the Western highlands of Cameroon through a screening of bean accessions related to their resistance to fungal diseases. The study made it possible to identify three main fungal diseases of common beans present in the study area. These are angular leaf spot (ALS), floury leaf spot (FLS) and rust. Among the dwarf accessions, RWR 3194 gave the highest average yields in 2020 and 2021, and among the climbing accessions MAC 55 gave the highest yield in both years of trial. Some accessions proved resistant to ALS, namely Banguem and RWR 3194, while Mancha 3 was among the most sensitive accessions to ALS. Mac 55 and RWR 3194 could be recommended as high yielding and also with a good resistance to the main fungal diseases encountered in the study area.

Acknowledgements

The authors acknowledge IRAD Station of Dschang and the phytopathology laboratory of the Faculty of Agronomy and Agricultural Sciences of the University of Dschang where the field experiment and laboratory analyses took place respectively. Our appreciation also goes to IRAD Station of Foumbot that provided the beans accessions for the experiment.

References

1. Diaw, N. F. "Utilisation des inoculums de rhizobium pour la culture du haricot (Phaseolus vularis) au Sénégal. " *Diss. Thèse Doctorat. Université Cheikh Anta Diop. Dakar*, (2002).
2. Djeugap, F. J., Mefire, M. H., Nguefack, J., Ngueguim, M., & Fontem, D. A. "Effet variétal et du traitement fongicide sur la sévérité de la maladie des taches angulaires et le rendement du haricot commun (*Phaseolus*

vulgaris L.) à l'Ouest-Cameroun." *International Journal of Biological and Chemical Sciences* 8.3 (2014): 1221-1233.
3. Teame Gereziher, T. G., Ephrem Seid, E. S., & Getachew Bisrat, G. B. "Performance evaluation of common bean (*Phaseolus vulgaris* L.) varieties in Raya Valley, Northern Ethiopia." (2017): 1-5.
4. González, A. M., Yuste-Lisbona, F. J., Saburido, S., Bretones, S., De Ron, A. M., Lozano, R., & Santalla, M. "Major contribution of flowering time and vegetative growth to plant production in common bean as deduced from a comparative genetic mapping." *Frontiers in plant science* 7 (2016): 1940.
5. Nchangi, E. B., Siri, B. N., Johworker, T. & Lutomia, C. "Analysis of common bean (*Phaseolus vulgaris* L.) trade in Cameroon: a trader's perspective of preffered varieties and traits." *Journal of Agriculture and Food Research* 14 (2023): 100839.
6. Ngueguim, M., Mekontchou, T., Fobasso, M., & Nounamo, L. "Influence of time of planting on yield and grain quality of bean genotypes grown on an andosolin the western highlands of Cameroon." *African Crop Science Journal* 19.4 (2011): 247-254.
7. Sanyang, S. F., Yaouba, A., Kinge, T. R., & Tankou, C. M. "Survey of cultural practices and assessment of some foliar fungi diseases of common bean (Phaseolus vulgaris L.) in the western highlands of Cameroon." *Methodology* (2017).
8. Siri, B. N., Joyce, B. E., Ambe, T. E. & Molua, E. L. "Understanding the production and sales determinants of haricot beans (*Phaseolus vulgaris* L.) in the Western Highlands of Cameroon." *International Journal of Development Ressources* 7.09 (2017): 15126-15133.
9. Siri, B. N., Nchanji, E. B. & Tchouamo, I. R. " A Gender Analysis on the participation and choice of improved and local haricot bean (*Phaseolus vulgaris* L.) by farmers in Cameroon. " *Agricultural Sciences*, 11 (2020): 1199-1216.
10. Soltner, D. "Les bases de la production végétale." (2003).
11. Tekle Yoseph, T. Y., Getachew Gashaw, G. G., Wondewosen Shiferaw, W. S., Simon, T., & Ermias Mekonnen, E. M. "Evaluation of common bean [Phaseolus vulgaris (L.)] varieties, for yield and yield components." (2014): 22-25.
12. Wortmann, C. S. "Atlas of common bean (Phaseolus vulgaris L.) production in Africa. " No. 297. *CIAT*, (1998).
13. Zilio, M., Souza, C. A., Coelho, C. M. M., Miquelluti, D. J., & Michels, A. F. "Cycle, canopy architecture and yield of common bean genotypes (Phaseolus vulgaris) in Santa Catarina State." *Acta Scientiarum. Agronomy* 35 (2013): 21-30.

Source of support: Nil;
Conflict of interest: The authors declare no conflict of interests.

Cite this article as:

Meka S. S., Afsah M. N. M., Babagnack B. F., and Djeugap F. J. "Screening of Common Bean (*Phaseolus vulgaris* L.) Accessions for Their Resistance to Fungal Diseases." *Annals of Plant Sciences.*14.11 (2025): pp. 7034-7045.